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Final Report

**INDOT MULTIMEDIA APPLICATIONS
PROTOTYPE DEVELOPMENT**

Bob McCullouch

July 14, 1997

Indiana
Department
of Transportation

Purdue
University

Final Report
INDOT Multimedia Applications Prototype Development

by

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School of Civil Engineering

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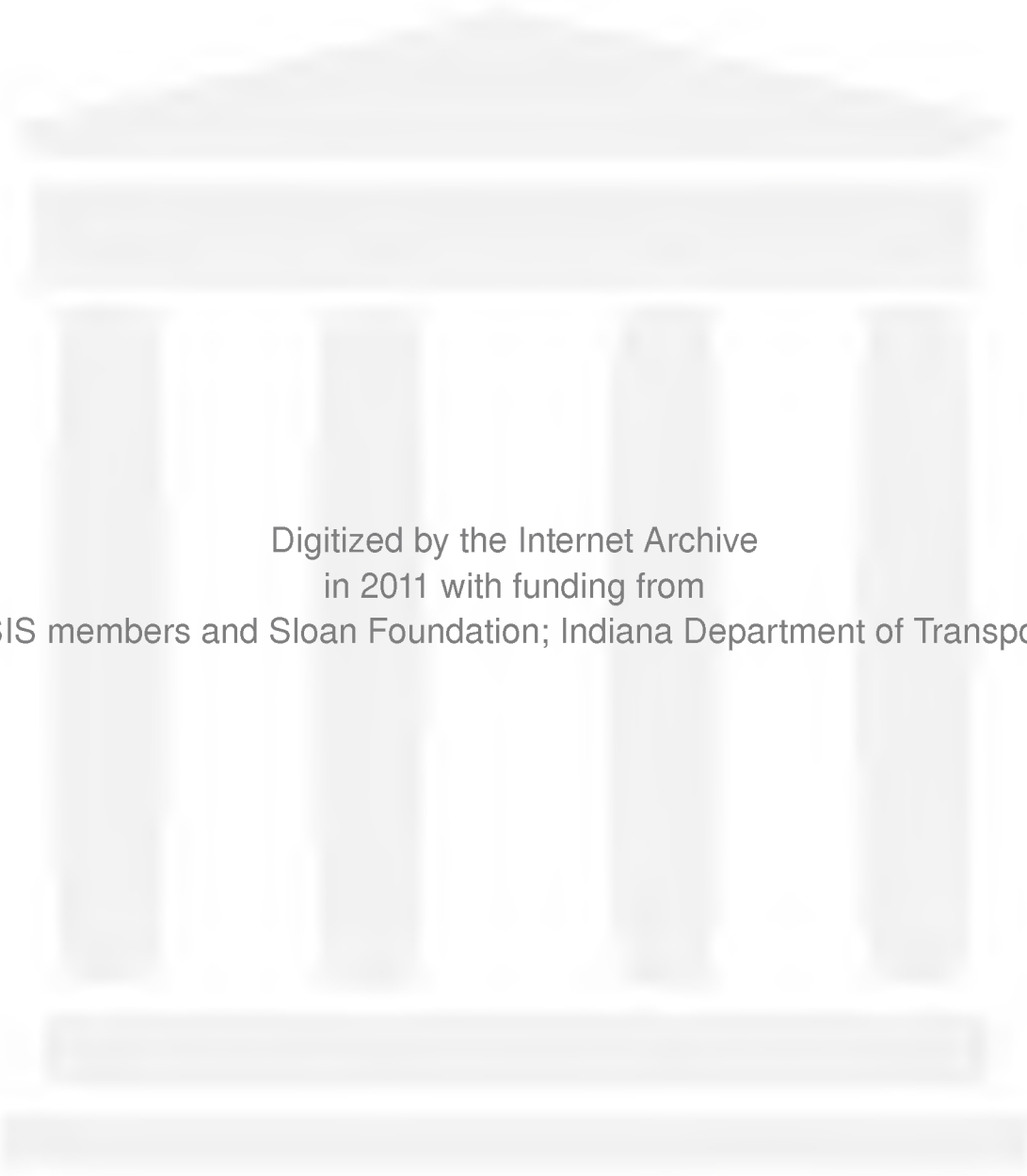
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and

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16. Abstract Multimedia technologies open a new data set for DOT organizations. By adding pictures, sounds, animation, and video, new computer applications can be developed that will bring many benefits. This project investigated the utilization of multimedia into DOT operations. Applications were developed in three different topical areas: Employee Information or Orientation, a Bridge Plan Reading course, and a Construction Equipment utilization prototype. The first two are fully developed implementable tools that will be utilized by INDOT. These developments provide insight into how multimedia can be a useful tool for training and providing performance support to DOT employees. Other tools can be developed like these that provide the benefits of reduced training time and reduced costs, while improving the training and work processes. Also, performance support is very important to INDOT or any other organization that has gone through downsizing while the volume of work has increased.					
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Introduction

Multimedia and its associated technologies provides some exciting opportunities for DOT organizations. One recent trend within these organizations has been a personnel downsizing mode causing pressures within, resulting in challenges that must be dealt with. At the same time downsizing has happened, expansion in transportation facilities has occurred. Data supporting this shows that in the last nine years INDOT staff levels have dropped from 8400 to 4800 while annual construction volume has grown from \$380 to \$520 million. One of the challenges is how to support the staff at these levels while implementing and overseeing more. Another result is that as staff leaves or retires valuable knowledge or experience goes. Multimedia tools can be developed to help deal with these challenges by providing performance support tools to staff. This report describes the experiences obtained, the products produced and through them illustrate how this technology can be used to solve some of these challenges facing the Department.

Problem Statement

A previous JHRP project titled "INDOT Constructability System Working Module" utilized multimedia(video, sound, graphics, design details, text, etc.) to train design engineers in constructability problems and issues. The computer tool developed in this project has been well received within INDOT and has stimulated interest for applying multimedia to other INDOT tasks, both technical and nontechnical. A short synthesis study, "Multimedia Application Synthesis Study", was funded and performed in 1994, to provide information and determine the feasibility of utilizing this technology within

INDOT.

The synthesis study report describes how multimedia is being utilized in other industries; what technologies comprise multimedia and their capabilities and roles; multimedia hardware requirements; multimedia software options; implementation issues; and INDOT needs applicable for multimedia utilization. This report provides a foundation of information for INDOT in the emerging technology of multimedia and results from this study provide a starting point for the development of multimedia applications. A list consisting of five candidates were recommended for prototype development within this project.

Project Objectives

The "Multimedia Application Synthesis Study" identified five candidates for prototype development. The study advisory committee decided that four would be developed through this proposed research project. The fourth candidate, Permit Procedures, was undergoing a major revision and not a good candidate at this time and consequently was removed from the list. The three candidates for development are:

1. Metric Training/Highway and Bridge Plan Reading
2. INDOT Orientation Training
3. Construction Equipment Capability and Utilization

These three candidates provided adequate experience and diversity for the development experience.

The following describes basic background information on each of the three candidates.

Metric Training/ Bridge Plan Reading

The current course for Highway/Bridge plan reading was developed in 1965. It is a self-study course that consists of two plan sets, a highway and a bridge project, a study guide and an evaluation or quiz section. It currently takes an entry level engineer approximately 40 hours to complete. This course needs updating and with the change to metrics, now is an appropriate time to do it. A multimedia course that teaches the same principles as the current one and incorporates metric conversion could be developed that would probably reduce the user time while improving the educational value.

Orientation Training

The orientation and information an employee receives at initial hire sets the tone for their exposure to and understanding of the organization. Currently, orientation consists of an interview conducted usually by an administrative manager or payroll clerk. A checklist is used to cover the various topics which ranges from employee benefits to specific office procedures. After the interview is conducted the employee reports to his/her supervisor. Each supervisor is responsible for thoroughly orienting the employee to his/her specific job functions and providing the necessary guidance and coaching to assist the employee in understanding how his/her role fits into the big picture of INDOT. Many supervisors take an active role in making sure employees gain the exposure they need to perform his/her job however, the process could be improved

and even expedited with the use of multi-media. INDOT is responsible for over 11,000 miles of road, 38 public transit systems, 39 railroads and 649 airports. The department is headquartered in Indianapolis. In its field operations, the department has six district and 37 sub-district locations, as well as, the toll road. It is difficult for any employee to understand the operations of such a large organization. The exposure of central office personnel to the field operations and the field operations personnel to central office is very limited. The use of multi-media could provide a realistic exposure to the operations and functions of the department. Thus, the employee has a better understanding and knowledge of the organization which can assist him/her in performing his/her specific job duties.

Employee Performance Support System for Design Division

Information Services is continuing the effort to provide electronic tools for the design division. Besides CAD, design standards and specifications are currently being developed into electronic form. Also, a constructability tool is being developed through JHRP that will operate on a PC to provide constructability lessons learned utilizing multimedia. Other types of information can be brought to the design division that along with these tools create a designer performance support system. Through multimedia information on contractor equipment or equipment capability, contractor materials, and construction methods can be provided. A contractor equipment capability module prototype was developed to illustrate how this type of tool could be utilized.

Project Activities

A development team organized consisted of Purdue faculty in the School of Civil Engineering and INDOT personnel - representing training, engineering, information services, and other divisions and/or sections associated with the application. This team directed an effort to develop prototypes for each application described above. An application action team was formed for each prototype candidate. This action team consisted of individuals familiar with the application and were used to define its content and structure. For each application candidate, the development effort consisted of: 1. selecting the appropriate development tool for each application; 2. designing the presentation approach; 3. collecting the appropriate data content to include ; 4. testing the prototype for user reaction; 5. releasing implementation versions; and, the last activity is to train personnel within INDOT on how to develop and implement multimedia applications. Transferring this expertise and having the ability to perform it internally within INDOT is the final goal of the project.

Development Tool Selection

The first activity was to determine the development tool for each proposed candidate. This involved analyzing each candidate requirements and the goals to be achieved . An important step is identifying the media data(video, graphics, sound, text) needs.

Several types of authoring products are available for the multimedia application development environment. They are different, and their capabilities should be judged carefully when planning application development. Some of these tools are described

next.

Visual Basic provides a programming environment that provides all the tools required to develop an application, including an editor for writing code, utilities for examining the elements of environment, and so on. Visual Basic, enables the use of the graphic interface of Windows to create an application.

Another kind of product uses scripting. Scripting is like programming, but comparatively simpler. Multimedia ToolBook is a good example of scripting. Programming environments, authoring packages, and script based software come in all degrees of power and complexity. Any one type of product is not necessarily easier to use than another, each programming product must be judged on its own merits.

Authoring Tools

Multimedia authoring tools organize and edit elements of multimedia projects, including graphics, sound, animations, and video clips. Authoring tools are used for designing interactivity and the user interface, so the various elements are made into a cohesive project. The contents and function of the project are bound together into integrated environments. The following are tasks an authoring tool performs.

- Video productions
- Animations
- Presentations
- Interactive guided tours
- Interactive kiosk application

- Interactive training
- Simulations, prototypes, and technical visualizations

There are various kinds of authoring tools available that are categorized according to their use in sequencing and organizing multimedia elements and events.

These are :

- Card or page-based tools
- Icon-based, event-driven tools
- Time-based and presentation tools

Card and Page Based Authoring Tools

In card based authoring systems, elements are organized as pages of a book or a stack of cards. The authoring system facilitates linking these pages and cards in an organized sequence. One can access any page or card through a structured navigational pattern. Many developers arrange their images into logical sequences or groupings similar to the chapter and pages of a book, or cards in a card catalog. Navigational routines then become the directives to go to a page or card that contains appropriate images and text, and associated sounds, animations, and video clips.

The page-based authoring systems are object-oriented and each object may contain a programming script which is activated when an event (such as mouse click) related to that object occurs. Most page based authoring systems provide a facility for linking objects to pages and cards.

Icon Based and Time Based Authoring Tools

In icon based tools the multimedia elements are organized in a structural framework or process. These tools simplify the organization of the project as well as display the flow diagrams for the activities. These flow diagrams become all the more important in long and intricate programs. Icon-based event driven tools provide a visual programming approach so as to organize and present multimedia. There are certain steps that are to be followed, starting with building a flow chart of events, tasks, and decisions by dragging appropriate icons from a library. These icons include menu choices, graphic images, sounds and computations. The flow chart graphically represents the project's logic. After the logic is represented by the flow chart, text, graphics, animation, sounds, and video movies are added. In order to refine the project, icons can be rearranged and properties having special effects can be added.

In time-based tools, elements and events are organized along a time line, with video playback rates as high as 1/30 second. Sequentially organized graphic frames can be played back at a speed set by the user. This type of tool enhances navigational and interactive control. Visual programming is the simplest authoring process. The element's icon is dragged to the flow diagram or away to delete it. These kinds of authoring tools are the most common multimedia authoring tools. Each uses its own interface for managing events over time.

Multimedia Shells

Building a Multimedia or Computer Based Training (CBT) program can take a considerable amount of time. Applications can take a few months up to at least two years to develop. One of the reasons is it takes a large number of resources just to develop the user interface. The user interface is one of the two most essential parts in the multimedia programs with the lessons being the most important. However, the users interface is the second most important part of the program because it provides navigation and communication to lesson contents.

Most multimedia shells are based on one authoring tool. However, shells are already equipped with help system, expert training templates, pre-designed training events, easy drop-in information templates, and automatic lesson flow with interaction and feedback. These shells allow developers with no computer based training (CBT) background to produce high quality CBT. Since these shells are based on one or some authoring tools that are available in the market, modification can be made if needed.

Based on case histories utilizing multimedia shells can reduce development time by up to 80%. Therefore, a training manager can concentrate on the lessons itself without thinking about the navigation and communication to the lessons. In addition, most of the shells provide learners record keeping, proficiency evaluations, and skill assessment. These features can be used for evaluation of the learning process.

Tool Selection

Resources from the Multimedia Design Lab at Purdue University School of Civil Engineering were used in the evaluation and selection of software development tools. Besides an authoring tool, other software are needed. Tools for working with pictures, graphics, sound, animation, and video are necessary. These tools provide the capability to develop these data forms so they can be brought into the application.

Three icon-based authoring tools were evaluated: Icon Author, Director, and Quest. After the evaluation period, Quest was selected as the tool of choice in developing the applications. The main reason for its selection was that for CBT civil engineering applications it provided the most capabilities and seemed to be the best fit.

The shell *WorldTutor* was seriously considered. A demonstration was attended and references checked out. But it was not chosen primarily because of its price(\$10,000) and lack of features.

Presentation Approach

For each application the presentation methodology was designed. This step establishes goals and objectives for each application and the format and information needed. A flowchart structure was designed and used as the "blueprint" to guide the development effort. Based upon the review of existing software tools the presentation approach was built around the selected software.

Application Descriptions

The applications are different in content but also in the approach taken. The Employee Orientation and Bridge Plan Reading applications are actual working tools

that can be implemented at INDOT. The Construction Equipment application is a prototype which is what the project called for. However, this prototype does contain some useful information on construction cranes and asphalt rolling equipment. It is structured for future expansion. A description of each provides insight into what multimedia can deliver to INDOT. A user manual for each is provided in the Appendix.

Employee Orientation

This is an electronic reference tool for INDOT employees. This tool contains information about INDOT's Mission, Values, and Goals; a video that describes how the department functions; a short history video; a description of the organization and the various divisions; district information; central office information; and "employee handbook" type information. Handbook information includes work procedures, benefits, employee development, and employee relations.

Bridge Plan Reading

This tool explains how to read and understand a set of bridge plans developed by the Design Division and it tests and grades the student to determine their plan reading competency. The tool utilizes screen zooms, color, popups, and multimedia(pictures, sound, video, animation). The tool reduces the amount of time to take the course while improving the comprehension level by engaging the user through a more interesting and entertaining experience. Sound is used extensively for explanation purposes and it speeds the instruction process. Pictures and video clips of the actual bridge brings realism to the set of engineering drawings. The tool has bookmarking capability which means the student can exit the application and return to

the exit location upon starting the application again.

Construction Equipment Capability

This tool utilizes multimedia to explain equipment capability and combinations.

Two equipment types, cranes and asphalt rollers, serve as examples.

Technology Transfer to INDOT

The final activity under this project is to train personnel within INDOT how to develop and implement multimedia applications. INDOT has created and filled a position in multimedia development. Training for this individual has consisted of multiple training sessions at Purdue University Civil Engineering Multimedia Lab as well as on-site training. Information transferred includes hardware and software operation, development approaches, application design instructions, and recommendations for support personnel, and hardware and software needs. Transferring this expertise and having the ability to perform it internally within INDOT is one of the most important products of this project.

Study Benefits

Multimedia with its ability to use various media forms, provides a richer environment to learn in. Learning improves significantly when media is used that exercises various human faculties. Studies indicate that students complete training in one-third the time of traditional instruction while reaching up to 50 percent higher competency levels. Utilizing this technology can provide improved training tools and learning environments for the Department.

Implementation Suggestions

This project laid the groundwork for multimedia development at INDOT. The three tools developed illustrate how this technology can be applied at INDOT to train more effectively and provide improved performance support to INDOT employees.

Implementation is underway through approval of a Multimedia Analyst position and subsequent filling of the position. This individual is being brought on line through training at Purdue and a gradual development experience. The first development exercise is the modification of the Constructability tool and its release sometime in Spring 1997. The implementation of the three tools developed under this project will start at the same time. Involvement in these activities will provide experience and "know-how" to expand the applications of multimedia and related technologies into INDOT operations.

Appendix

Employee Orientation

This application should be viewed as a reference tool for all INDOT employees. Information contained is applicable to all employees. Information is accessed from menus and are shown in the following figures. The below figure 1 is the main menu.

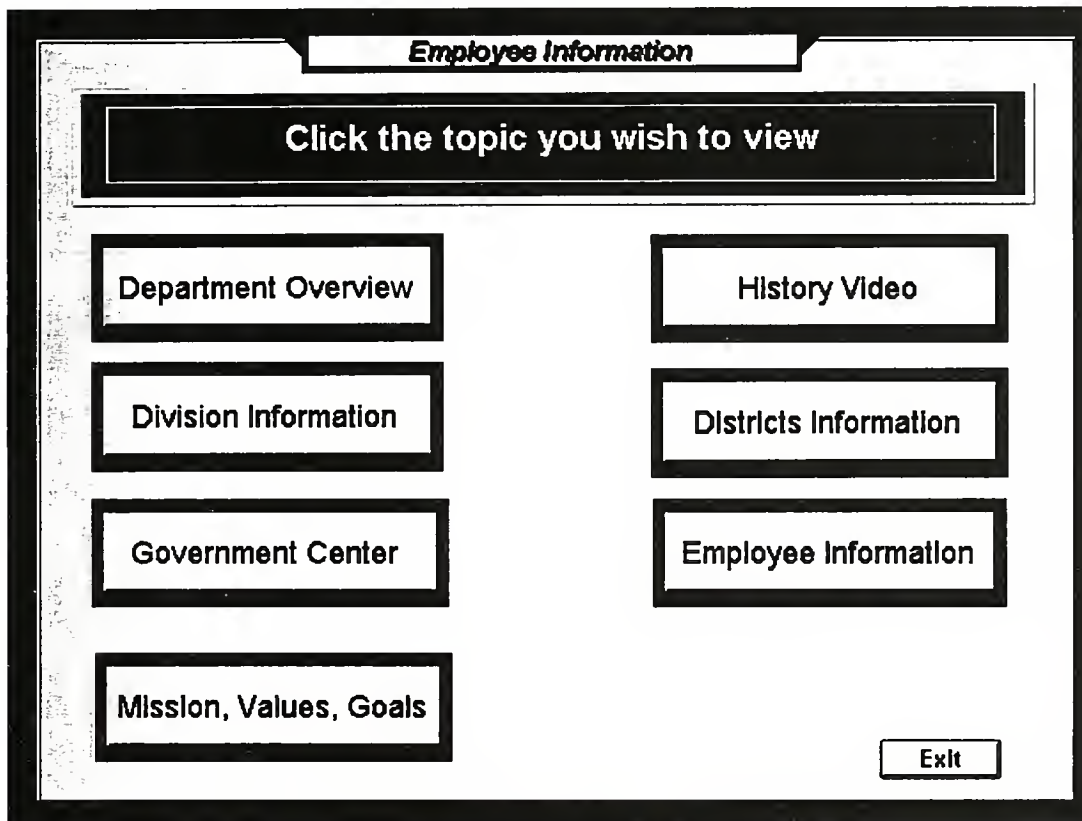


Figure 1 - Main Menu

This menu provides access to seven areas of employee information and a brief description of each button is provided next.

Department Overview is a nineteen minute video that uses a light-hearted story to describe what the Department does and how the various Divisions participate. This video was written, performed, and recorded with INDOT personnel. Figure 2 shows a

frame from the video.

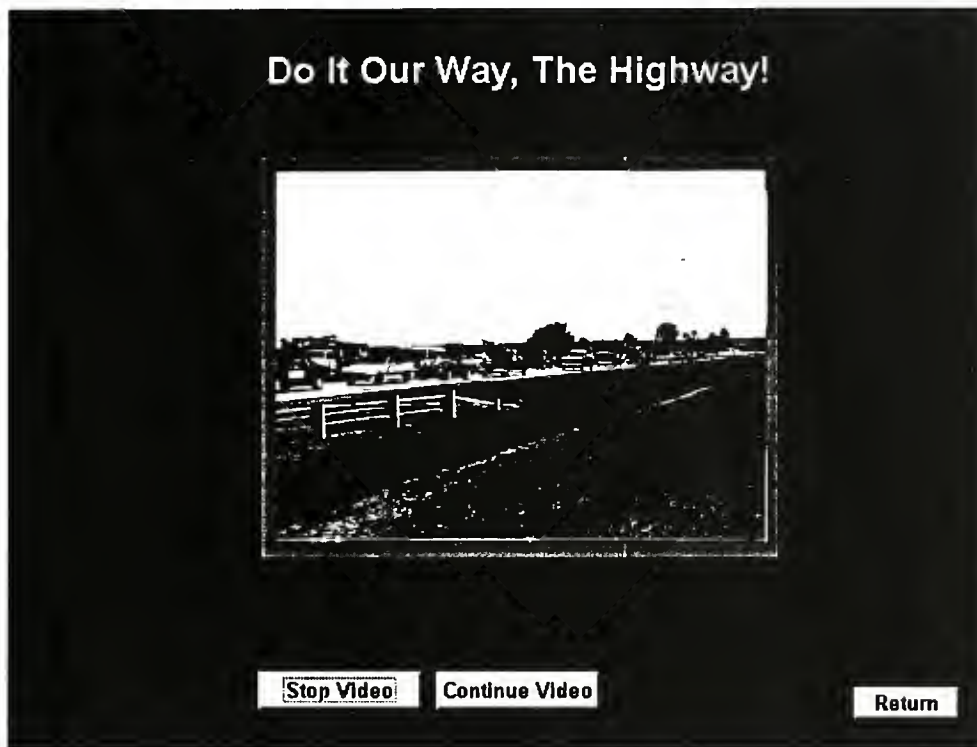


Figure 2 - Overview Video

Division Information utilizes a multimedia organization chart to explain what each division does. Clicking on a particular box starts a short address by the Division Chief describing what the division does. Below is the Organization Chart used.

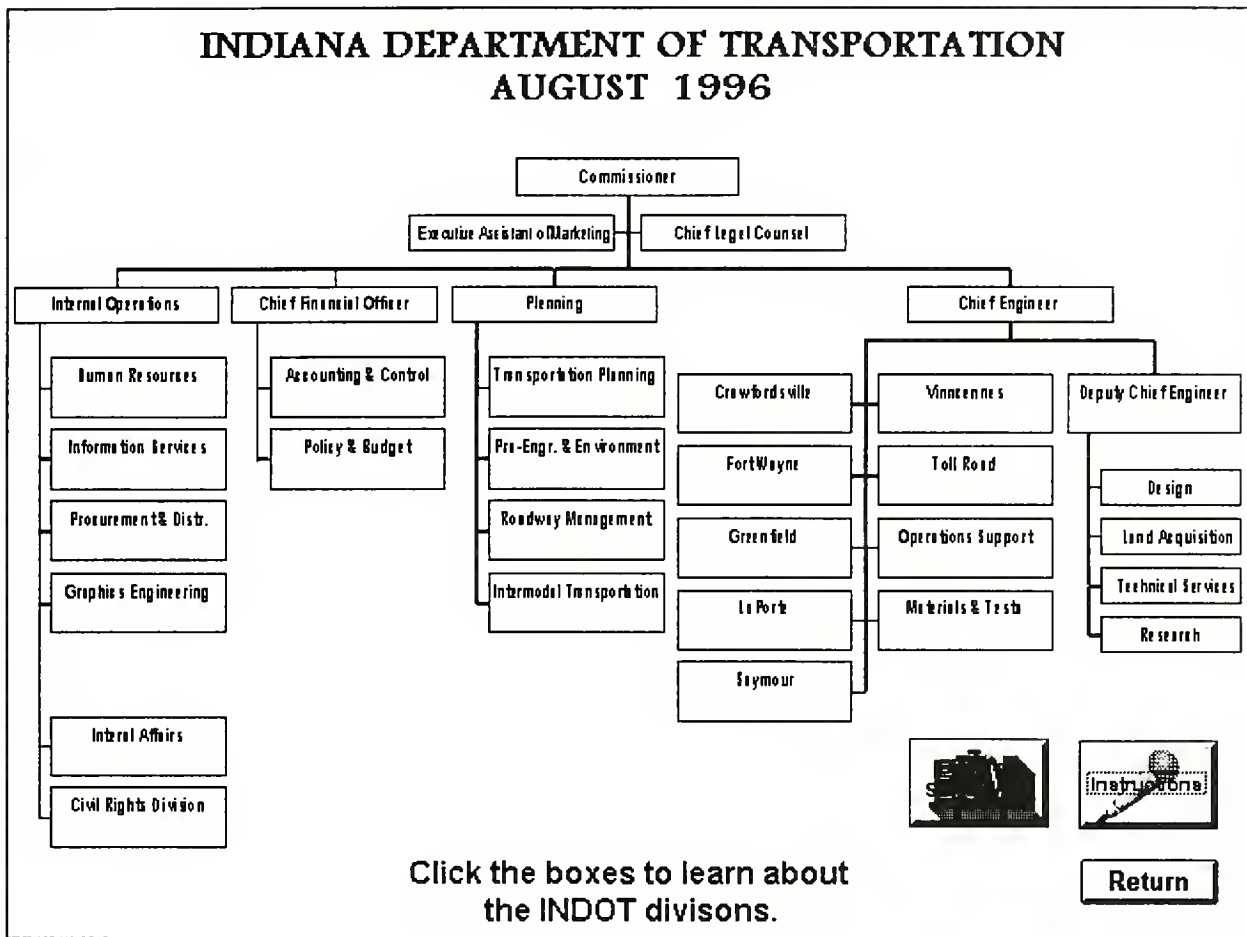


Figure 3 - Organization Chart

Government Center provides a map of the Indiana Government Center in Indianapolis.

Information on parking, where divisions are located, and general information on the center is provided.

Mission, Values, and Goals is a verbal and visual guided description of these topics.

History Video is a short video clip describing the history of the Department.

District Information starts with a state map divided into the six districts. Clicking a district will pull up its map. Each district map shows subdistricts and one can click and see information on personnel. Figure 4 is the Crawfordsville District map.

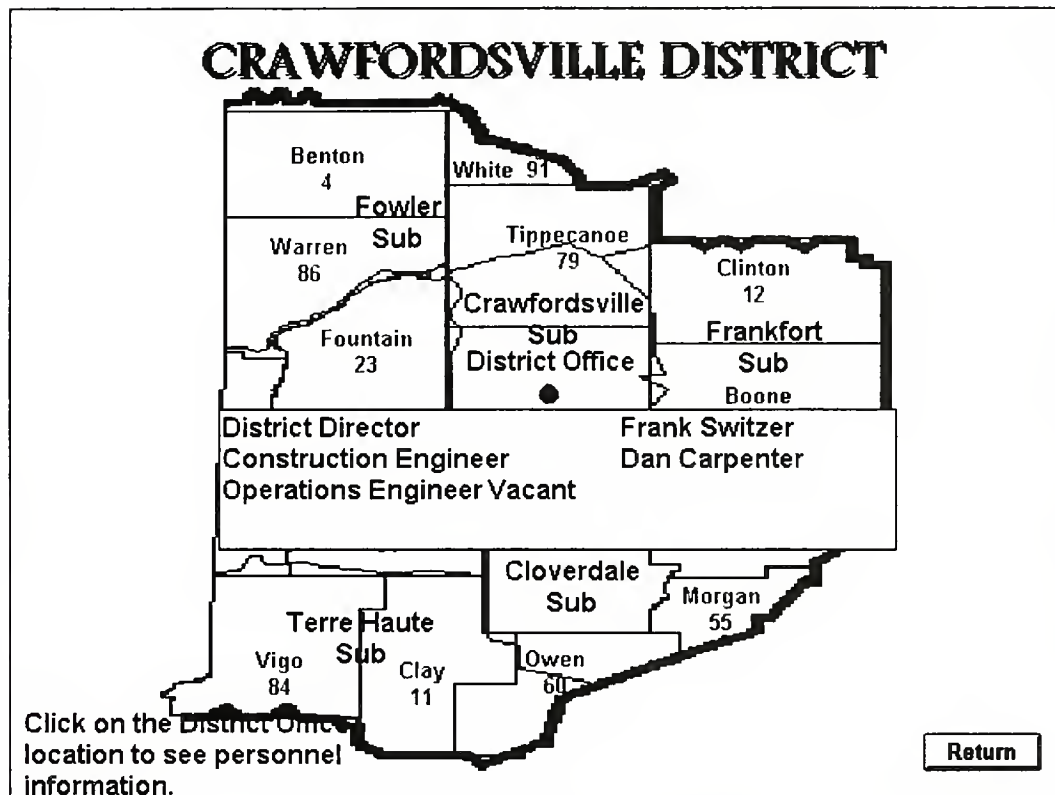


Figure 4 - Crawfordsville District Map

Employee Information opens up several other menus. The main menu contains four options shown in Figure 5.

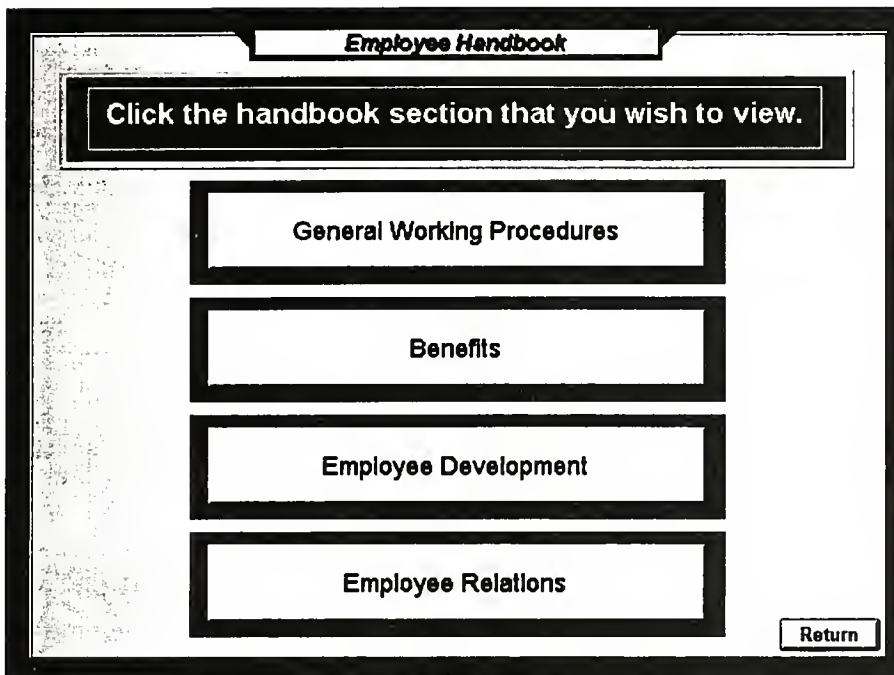


Figure 5 - Employee Information Main Menu

Each of these menu buttons opens a menu containing buttons. These four submenus are shown in the next four figures. Buttons on these menus access the corresponding information.

General Working Procedures		
Click the topic that you wish to view.		
Probationary Period	Travel Expenses	Drug/Alcohol Testing
Work Hours/Overtime	Employing Relatives	Personal Info/Files
Attendance/Absences	Ethics	Employee Safety
Payroll Procedures	Resignation	EEO Policy
Telephone Use	Political Activity	Sexual Harassment
Use of INDOT Vehicles	Smoking Policy	
		Return

Figure 6 - General Working Procedures Menu

Benefits	
Click the topic that you wish to view.	
Insurance Benefits	Employee Assistant
Retirement/Deferred Comp	Wage Increases
Worker's Comp/Disability	Direct Deposit
Employee Suggestions	Holidays
Credit Union	Leave of Absence
Taxsaver	
Return	

Figure 7 - Benefits Menu

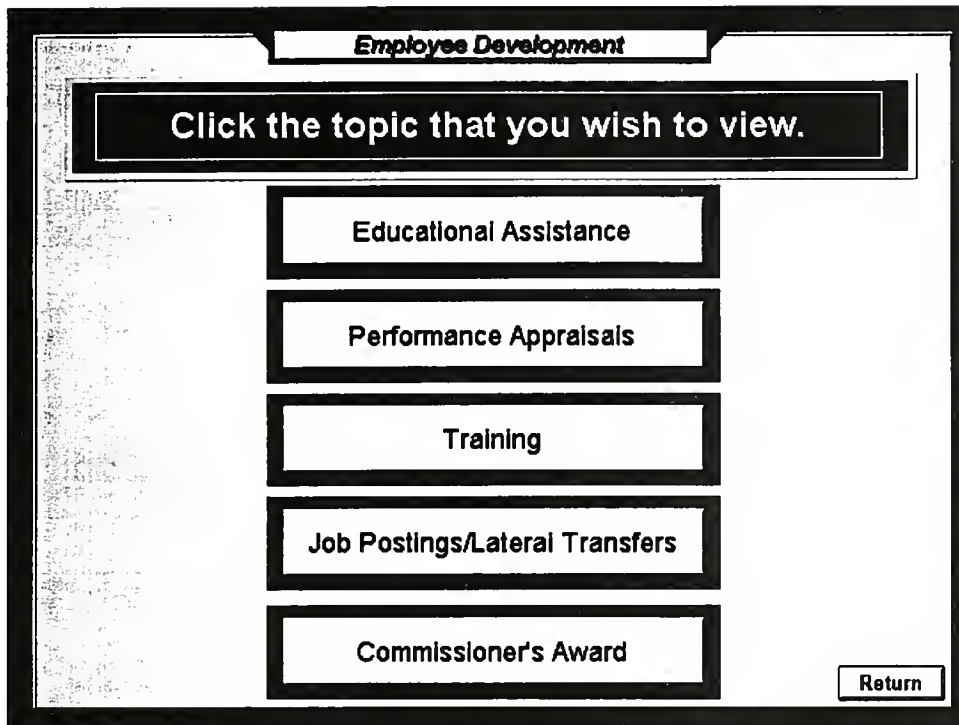


Figure 8- Employee Development Menu

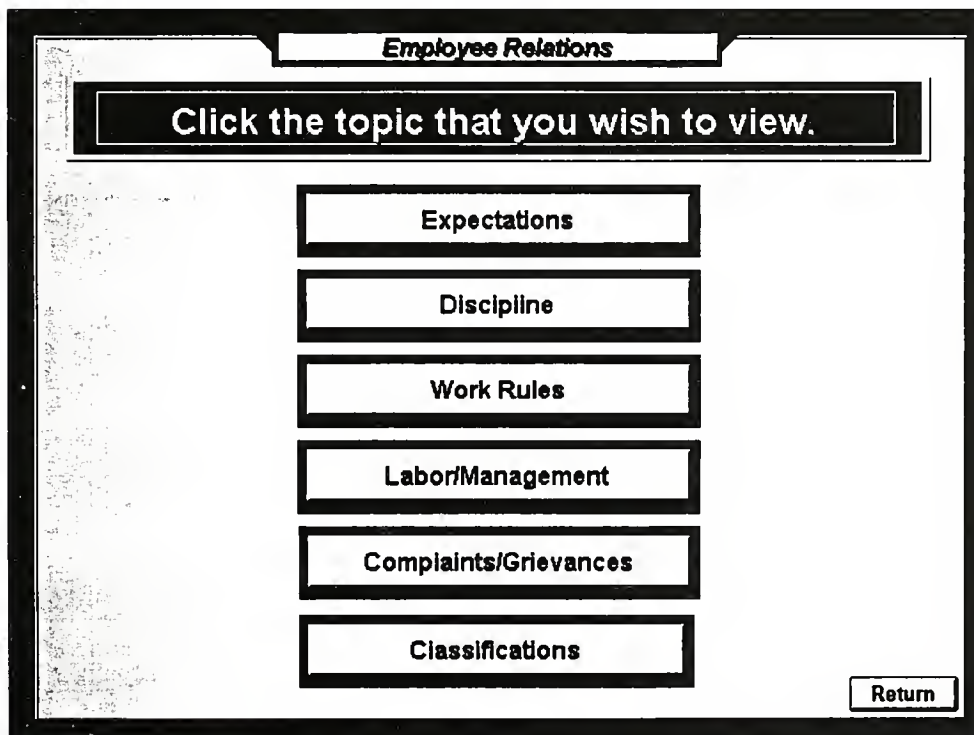


Figure 9 - Employee Relations Menu

The application was designed for maintainability. Most modifications can be performed by replacing or modifying a file. The application can be operated from a stand-alone PC or placed on the LAN server.

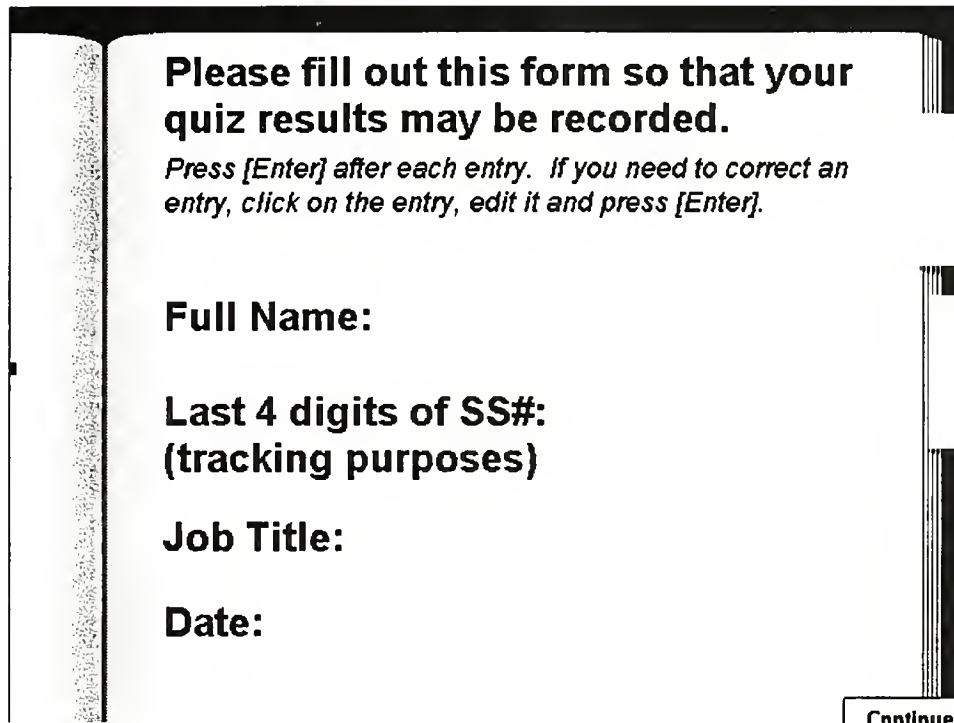
Bridge Plan Reading/ Metric Training

The objective of this tool is to explain how to read and understand highway bridge plans. The tool is designed to be interactive, stand-alone, and self-paced but a couple things are required to operate the tool.

First is a reduced set of drawings. These drawings will be used as a reference document to accompany the computer tool. The computer tool explains what is contained within the drawings through the use of color, sound, pictures, animation and video. The paper drawings are needed for viewing detail because on computer monitors CAD drawing details tend to be distorted.

The second requirement is each user needs a floppy disk containing two files. One file named results.txt will be used to record quiz answers. This file contains no data when given to the user. The second file is bookmark.txt. This file will be used to record a bookmark location if the user wants to leave the application and come back to it at another time. This file will contain one entry the name of the application frame location. Initially the file contains the word Intro, which is the first frame in the application. Both files can be created by notepad or a word processor and the floppy drive is the drive letter A.

The application is started by clicking the icon. **Check to make sure the floppy disk is in drive A.** The application moves to the below screen and waits for the user to fill in the requested information.



Please fill out this form so that your quiz results may be recorded.

Press [Enter] after each entry. If you need to correct an entry, click on the entry, edit it and press [Enter].

Full Name:

**Last 4 digits of SS#:
(tracking purposes)**

Job Title:

Date:

Continue

Figure 10 - Required User Info

After filling out the above form the user clicks the continue button and moves to the next screen. This screen contains an explanation of the standard buttons used and is shown in the below figure 11.

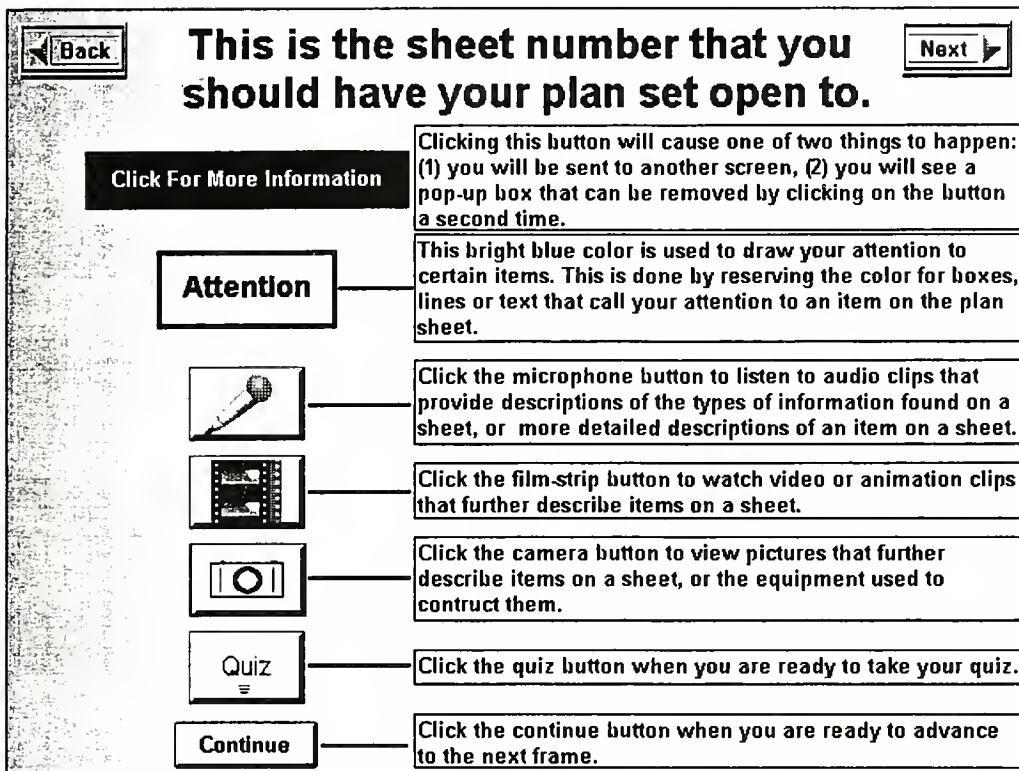


Figure 11 - Buttons Page

Notice at the top of this screen and most screens are two buttons used for moving to screens, Back and Next. Clicking these buttons moves sequentially forward or back through the application.

The below screens contain representative buttons which need explanation.

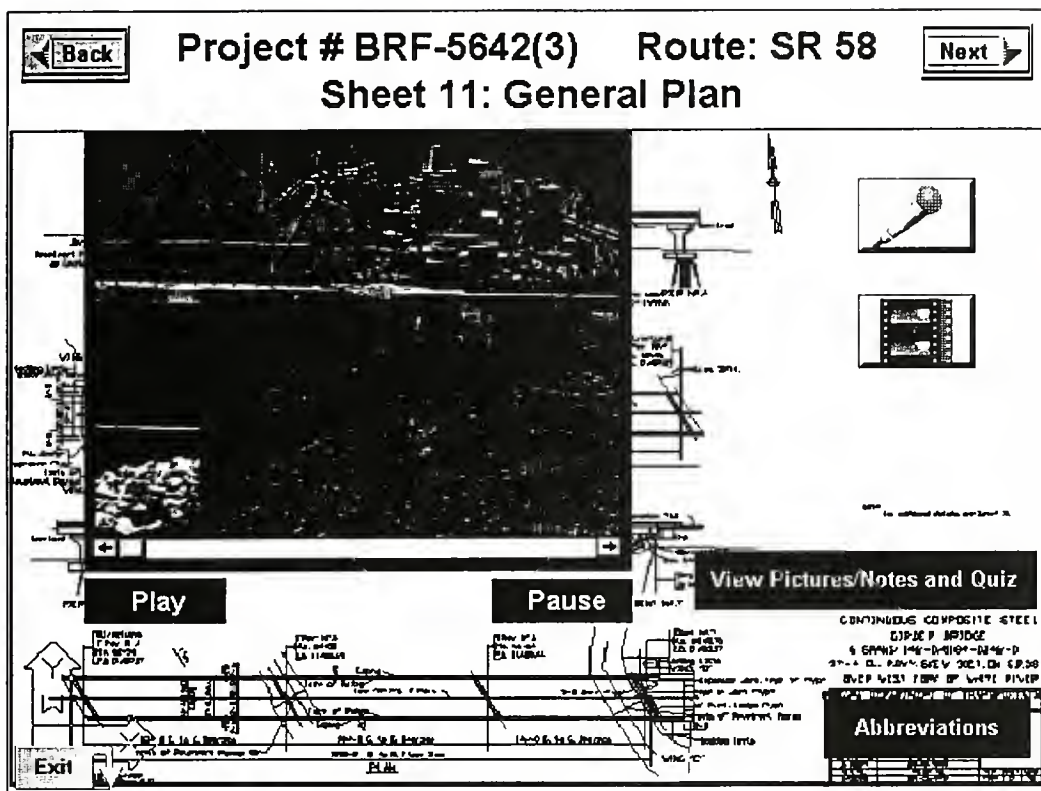


Figure 13 - Video controls

Below the video window are some controls. The Play button starts the video and the Pause button stops it. A slider bar allows the user to move the video forward and back. The video window will disappear after the movie plays to completion.

At the lower right in Figure 13 is the Abbreviations button. Click it and a popup window appears containing a list of the common drawing abbreviations. Figure 14 shows this popup. This popup is removed by clicking the X button located in the upper right.

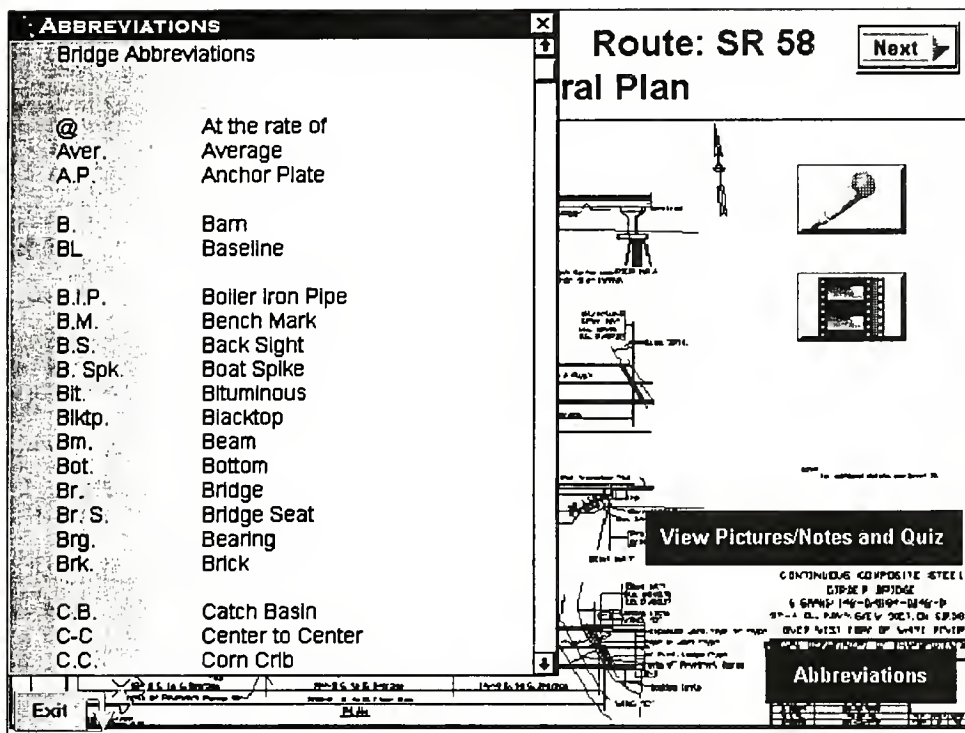


Figure 14 - Abbreviation popup

By now you may realize that a blue button generally creates a popup or another screen containing a zoom. Figure 15 shows a popup. To remove a popup click on the blue button that activated it.

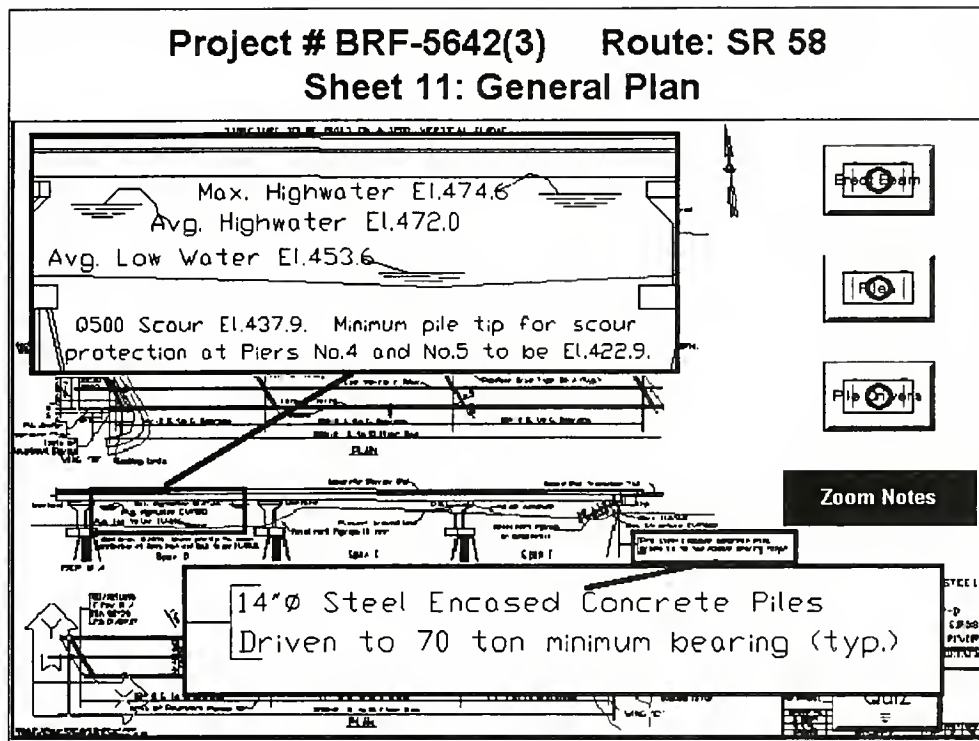


Figure 15 - Popups

The Quiz button is generally located in the lower right part of the screen. Click the button and a quiz screen appears similar to the one shown in Figure 16. The user enters an answer for each question. When the last one is entered then the correct answers appears, however the user is prevented from changing answers. This allows the user to determine why the answer is incorrect, where the correct information comes from and creates an interactive learning experience. Once a quiz sheet is completed the user is prevented from returning and retaking.

Use Sheet 11 of your plan set to answer the following questions.	
What is the minimum bearing capacity of the piles in tons?	
50	70
What is the maximum high water elevation?	
350	474.6
What is the dimension between the piers? (feet)	
175	184
Continue!	

Figure 16 - Quiz Screen

At the end of the application is a screen(Figure 17) containing English to metric conversion factors. Click on the category button to see the conversion factors.

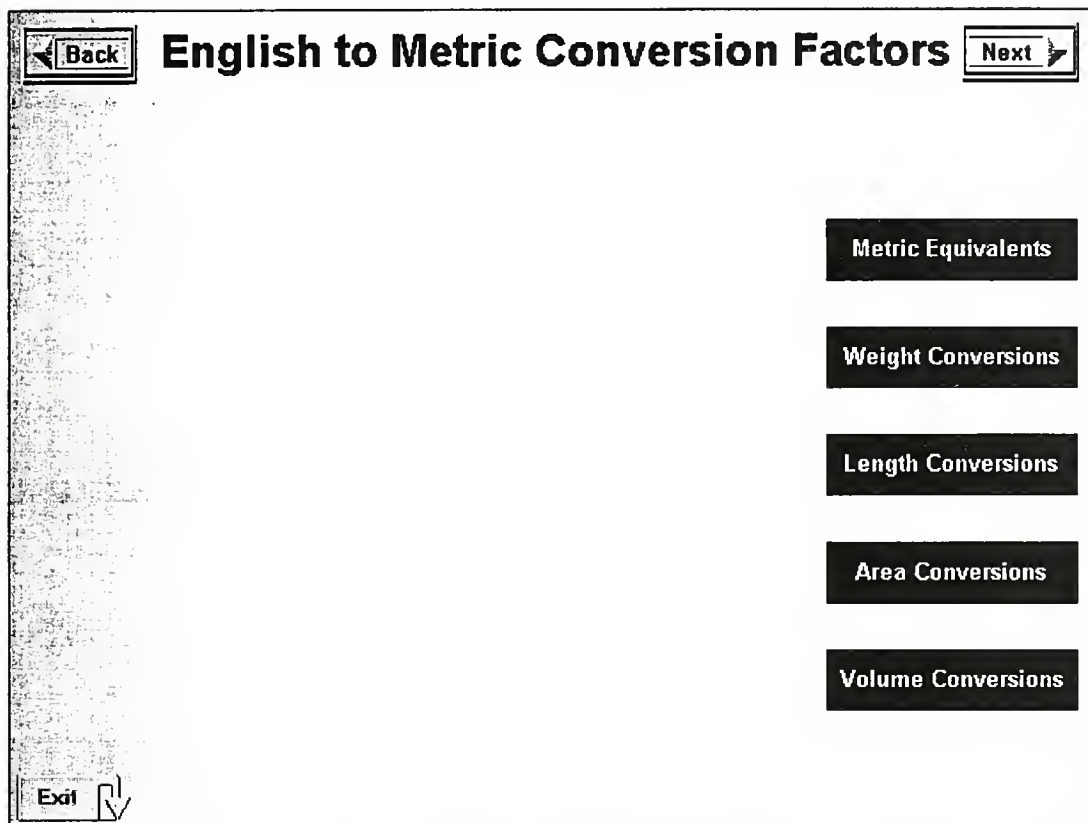


Figure 17 - Metric Conversion Factors

The Exit button is found on the screen in the lower left. Clicking on this will end the application as well as place a bookmark in the bookmark.txt file so that when the application is started again it starts where the user exited.

The application works at the pace of the trainee. All action occurs through mouse clicks. The only keyboard interaction is with the quiz answers. The quiz answers are saved to the floppy which is to be turned into the training supervisor.

Construction Equipment

Multimedia is utilized to describe equipment capability and utilization. This type of information on two equipment types , cranes and asphalt rollers, is contained. A few sample screens provide a description of the application. All action occurs through mouse clicks.

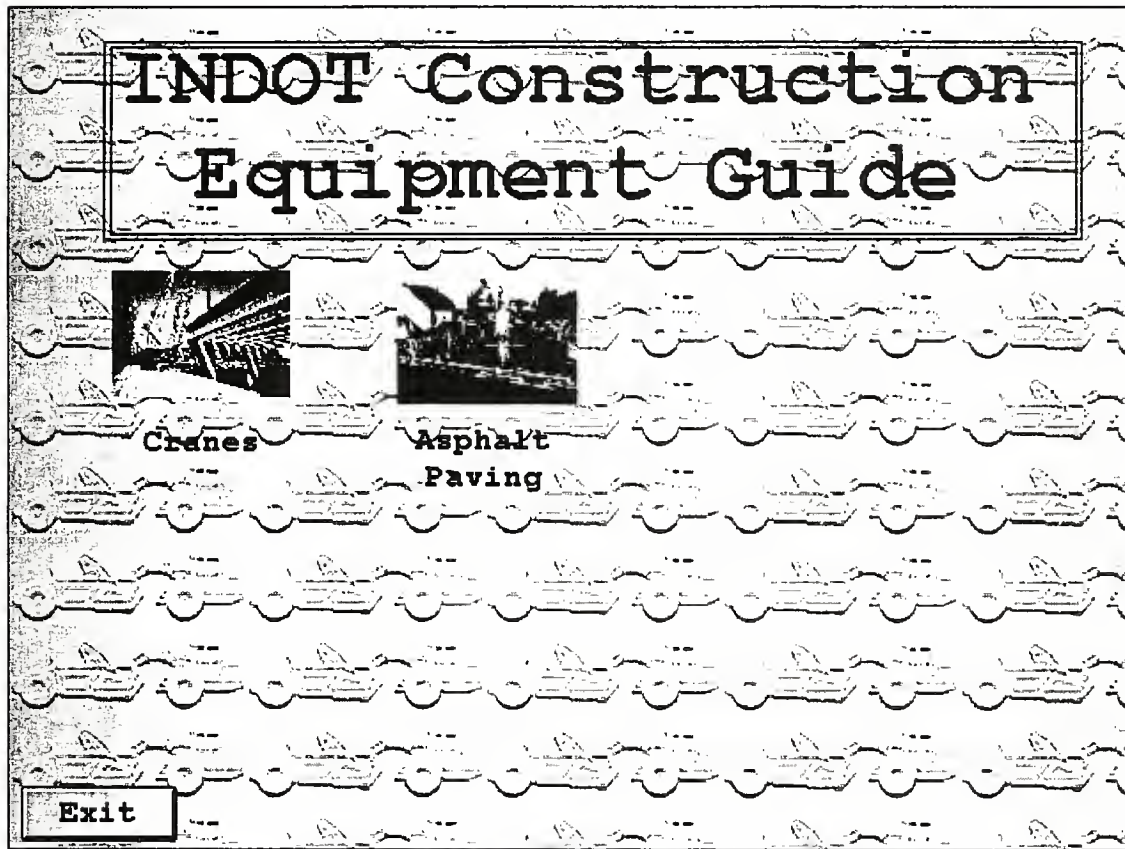


Figure 18 - Equipment Main Menu

Figure 18 is the application main menu. Only two equipment categories appear. You will notice plenty of room for expansion into other equipment types. If crane is clicked then figure 19 appears.

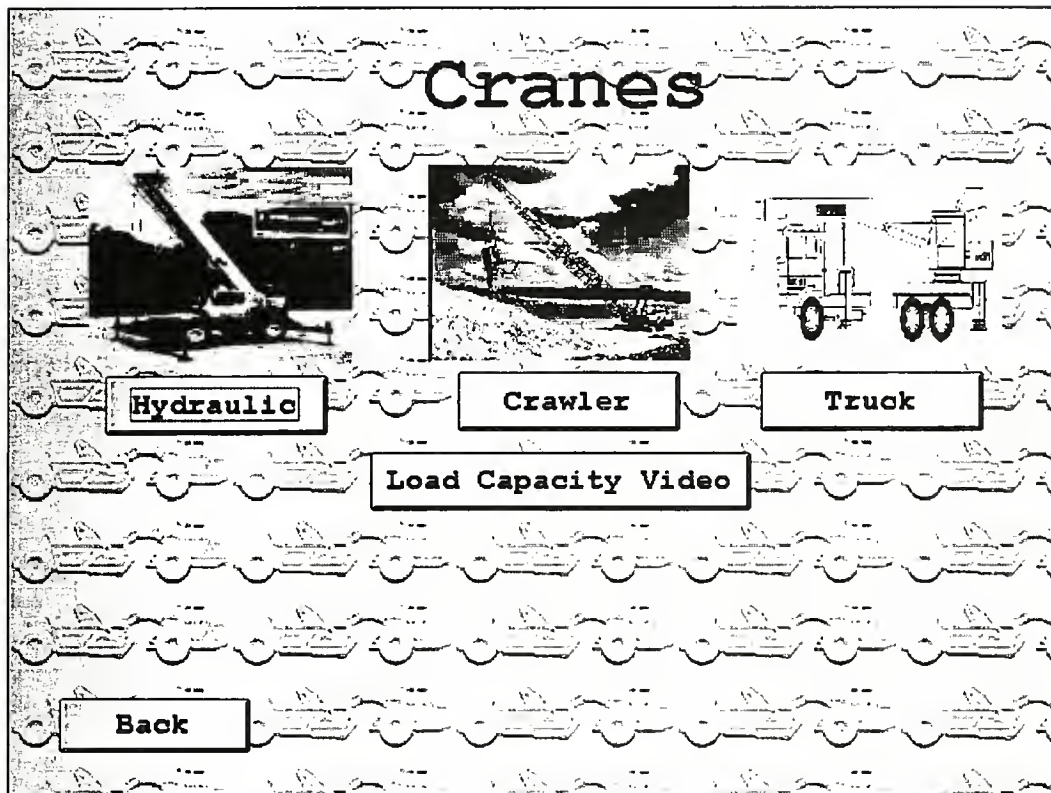


Figure 19 - Crane Menu

From this menu load capacity information on Hydraulic, Crawler, and Truck cranes can be accessed and compared. Also, an animation clip describes crane load capacity curves and values.

Clicking the Asphalt Paving button in Figure 18 opens the screen shown in Figure 20.

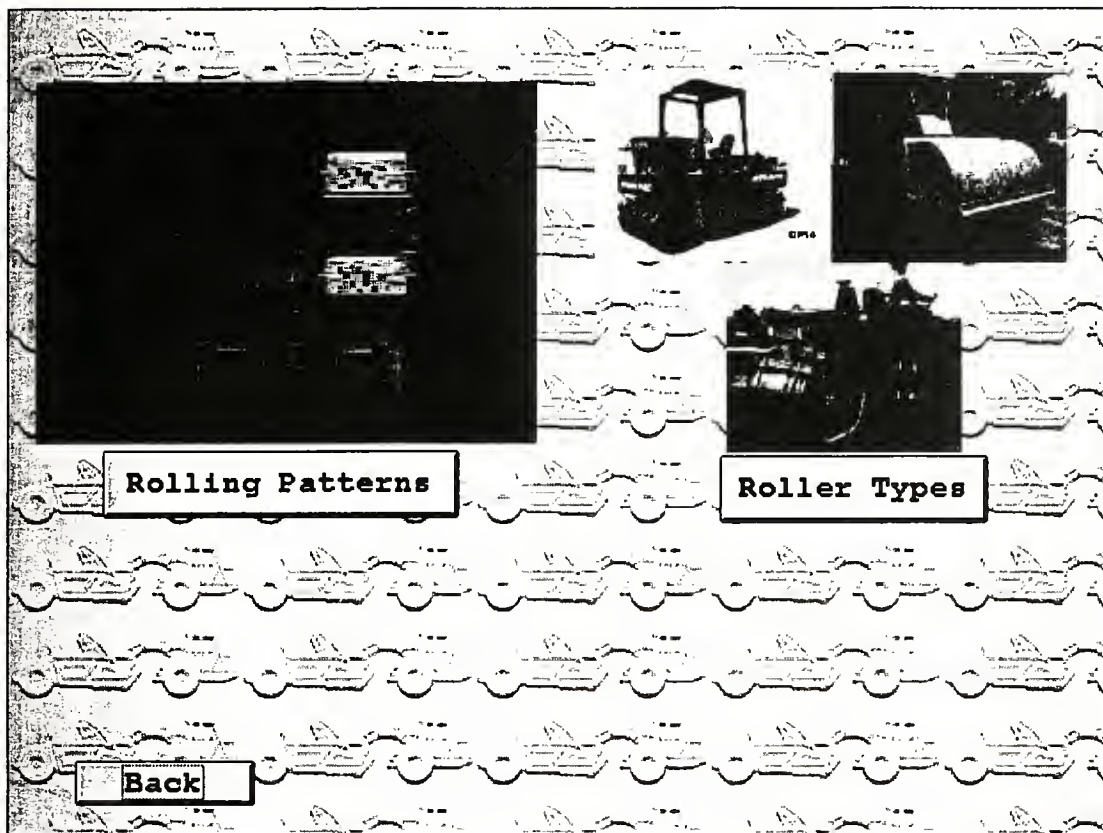


Figure 20 - Asphalt Rollers Menu

Buttons on this screen play video clips that describe rolling patterns and how the roller types Pneumatic, Static, and Vibratory operate and perform.

This application is a prototype which hopefully illustrates how information on construction equipment could be delivered to INDOT personnel.

